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LONG-TERM MANPOWER PROJECTIONS, PROCEEDINGS OF A CONFERENCE CONDUCTED BY THE RESEARCH PROGRAM ON UNEMPLOYMENT AND THE AMERICAN ECONOMY (WASHINGTON, D.C., JUNE 25-26, 1964).

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FORTY-ONE REPRESENTATIVES FROM EDUCATIONAL INSTITUTIONS, THE NATIONAL GOVERNMENT, AND THE NATIONAL SCIENCE FOUNDATION MET IN A 2-DAY CONFERENCE TO DISCUSS MANPOWER PROJECTIONS. GENERAL AREAS CONSIDERED WERE (1) METHODS NOW BEING USED WITHIN THE FEDERAL GOVERNMENT TO MAKE MANPOWER PROJECTIONS, (2) GROUPS OUTSIDE THE GOVERNMENT CONCERNED WITH MAKING MANPOWER PROJECTIONS, (3) PLANS FOR FUTURE WORK IN THIS FIELD, AND (4) THE PARTICULAR NEEDS OF THE USERS OF THESE PROJECTIONS. PERSONNEL FROM THE BUREAU OF LABOR STATISTICS (BLS) MADE THE FOLLOWING REPORTS--(1) "INTRODUCTORY STATEMENT ON THE BLS PROGRAM" BY HAROLD GOLDSTEIN, (2) "NOTES ON LABOR FORCE PROJECTIONS" BY SOPHIA COOPER, (3) "INDUSTRY EMPLOYMENT PROJECTIONS" BY SOL SWERDLOFF, (4) "BLS TECHNOLOGICAL OUTLOOK STUDIES" BY EDGAR WEINBERG, (5) "EMPLOYMENT PROJECTIONS BY OCCUPATION" BY JACK ALTERMAN, (6) "PLANS FOR THE YALE-M.I.T. GROWTH PROJECT" BY JAMES TOBIN, (7) "EMPLOYMENT PROJECTIONS BY OCCUPATION" BY CORA E. TAYLOR, (8) "ESTIMATES OF EMPLOYMENT BY OCCUPATION FOR FUTURE PERIODS, DATA SOURCES, AND MODEL DEVELOPMENT" BY HARRY GREENSPAN. SUMMARIES OF THE DISCUSSION FOLLOWING SOME OF THE SPEECHES ARE INCLUDED. SUGGESTED AREAS FOR FURTHER RESEARCH INCLUDED NONMANUFACTURING OCCUPATIONS, EDUCATIONAL POLICY, AND THE SKILLS REQUIRED AND THE NUMBER OF PEOPLE NEEDING TRAINING FOR EACH OCCUPATION. A LIST OF PARTICIPANTS WITH THEIR PROFESSIONAL AFFILIATION IS INCLUDED. (MM)

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# LONG-TERM MANPOWER PROJECTIONS

**Proceedings of a Conference
Conducted by the Research Program on
Unemployment and the American Economy
University of California, Berkeley**

**Washington, D. C., June 25-26, 1964**

**R. A. Gordon, Editor**

(This conference was financed by a grant of funds from the Office of Manpower, Automation, and Training, U. S. Department of Labor)

Institute of Industrial Relations
University of California, Berkeley
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# PREFACE

In 1962, a four-year program of research on the subject of Unemployment and the American Economy was begun on the Berkeley campus of the University of California. This program was made possible by a generous grant of funds from the Ford Foundation to the Institute of Industrial Relations at Berkeley. Professor Arthur M. Ross and I have served as co-directors of the project since it was initiated.

It was our idea from the beginning that, in addition to supporting scholarly research in the usual way, the Berkeley unemployment project would sponsor both regular annual conferences and also special conferences on particular topics as the need seemed to arise. Two regular conferences were held in 1963 and 1964, resulting in two volumes, Unemployment and the American Economy and Employment Policy and the Labor Market. A third conference is planned for the summer of 1965.

The special conference reported on here reflects the rapidly growing interest in the need for reliable long-term projections of the demand for and supply of labor. Meetings extending over several months with the makers and users of such projections, both in and out of the federal government, suggested that the time was ripe to bring together a group of specialists to discuss how manpower projections are now made and how the methods of making such projections might be improved. The Berkeley unemployment project agreed to sponsor the conference, and the Office of Manpower, Automation, and Training of the U. S. Department of Labor was kind enough to make available funds to cover the costs

of a two-day meeting in Washington, which was held June 25-26, 1964.

The U. S. Bureau of Labor Statistics played a key part in the conference. I owe a great debt to Mr. Harold Goldstein, Assistant Commissioner for Manpower and Employment Statistics, and his colleagues, for they agreed to accept a very difficult role. A representative of the Bureau of Labor Statistics consented to make the introductory comments on each of the topics to be discussed, with particular reference to the work now going on in the Bureau and also that planned for the future. As I emphasized in opening the conference, the purpose in this procedure was not to put the Bureau "on the spot," but rather (1) to inform the participants as to how manpower projections were currently being made and (2) provide a basis for discussion out of which might come suggestions for improving our methods of making manpower projections both in and out of government. Mr. Goldstein and his colleagues carried off this assignment in a most effective manner, and I should like to take this occasion to express to them not only my own thanks but also the appreciation of all the other participants.

I should also like to take this occasion to thank the Brookings Institution, which served as host to the conference, and Mrs. Marcia Schramm and Mr. Ralph Abascal, who helped with the arrangements.

R. A. Gordon

## OPENING REMARKS

By R. A. Gordon

The purpose of this conference is to bring about an exchange of information in the area of manpower projections. In planning these sessions, I had four general questions in mind:

1. What methods are now being used within the federal government to make manpower projections, and what groups outside the government are concerned with making manpower projections?

2. What can we learn about plans for future work in this field, both in and out of Washington?

3. What are the particular needs of the users of these manpower projections -- users both inside and outside the federal government?

4. Might not a full discussion of the projection techniques now being used lead to better understanding and more discriminating use of these projections? And might not some useful ideas for improving the methods now being used come out of such discussions?

It is not necessary to emphasize the importance of the subject that has brought us together. There is hardly a branch of the federal government that is not concerned in some way with estimating future manpower needs and resources. Similar needs exist at the state and local level. And these needs become steadily more urgent as we become more involved in manpower planning, in programs of education and training, in programs of regional and local development, and so on. Further, private users urgently require reliable

information on the details of the future demand for and supply of labor -- trade unions, business firms, trade associations, vocational counselors, and the like.

May I say a word about the role of the representatives of the Bureau of Labor Statistics in these sessions? I have called on the B.L.S. for help, and Mr. Harold Goldstein, Assistant Commissioner for Manpower and Employment Statistics, has been kind enough to suggest which of his colleagues might be willing to open the discussion on each of the topics on our agenda and report on the relevant current work and plans of the Bureau. The representatives of the Bureau listed in the program have each been good enough to take on the assignment requested of her or him, and I am sure that you will want to join me in thanking them all for being willing to share their knowledge with us.

I hope that each of these presentations will be followed by active discussion and that all of the participants will, like our speakers from B.L.S., share with us their particular knowledge in this field. While I am sure that the B.L.S. representatives will welcome suggestions and criticism, we should try to have a general exchange of views and information. For this exchange to be most fruitful, I think it is essential to begin with the current work and plans of the Bureau of Labor Statistics.

Hence I take great pleasure in introducing first Mr. Harold Goldstein, Assistant Commissioner for Manpower and Employment Statistics of the Bureau of Labor Statistics.

# INTRODUCTORY STATEMENT ON THE B.L.S. PROGRAM

By Harold Goldstein

In addition to the Bureau of Labor Statistics' broad concern with projections in connection with Department of Labor responsibilities in the field of manpower, the Bureau's interest in this field stems specifically from a recommendation of the President's Advisory Committee on Education in 1938 that an occupational outlook service be set up in B.L.S. to conduct studies of employment trends and the outlook in the various occupations, both for the guidance of individuals in their choice of a career and for the guidance of those responsible for planning programs of education or training.

The same basic research is needed for both these purposes, but they require different kinds of publications. For vocational guidance, generalized information is needed on the extent of employment opportunities in the future, together with information on working conditions, the nature of the work, and how one trains and qualifies for employment. For the guidance of educational and training authorities, quantitative estimates of the number of workers that have to be trained are needed. The Bureau's program has placed greatest emphasis on the first type of publication, but it has issued projections of training requirements as well. The first occupational outlook report was published in 1944, and since then reports have been published on many industries and on nearly all of the occupations requiring commitment of the individual to an investment in long periods of training, including the professions, skilled crafts, and many clerical, sales, and semiskilled occupations. The Occupational Outlook Handbook, first issued in 1949, is now in its sixth edition, and

about 40,000 copies of each edition have been sold, indicating a wide use in the 30,000 secondary schools and 1,800 colleges in the United States.

This research program represents one of the longest continuous and systematic efforts to make economic projections covering a wide spectrum of the economy, and to follow the developing events in each sector continuously in order to revise the projections at frequent intervals. Hopefully, something can be learned from this experience.

The B.L.S. has not considered it useful to follow the approach of conducting surveys in which employers were asked how many workers they needed in the future. Few employers have made any careful study of this question, and replies tend to be perfunctory. Instead, an analytical approach has been followed. Future trends in demand for each occupation have been assessed by developing information on the industries which employ members of the occupation and on the factors affecting the numbers of workers in each occupation that they employ. This requires estimating future demand for the products or services of each industry and the technological and other factors which may affect the relationship between production and employment in each occupation. This work has proceeded in several stages, which will be described by members of the Bureau's staff.

1. Projections of the size and composition of the population made by the Bureau of the Census are used as the basis for projections of the labor force, and also as a starting point for estimates of changing demand for various types of goods and services purchased by the different population groups. The projections of the labor force are made to provide both an estimate of the total labor supply and a basis for projections of GNP. Miss Bancroft and Miss Cooper will discuss this work.

2. The GNP and its composition are projected as a basis for projections of employment by sector. Mr. Swerdloff will describe work that has been going on, and Mr. Alterman will discuss new techniques now being developed, the so-called economic growth project.

3. The compilation of data and the analysis of trends in the occupational composition of the various industries will be described by Mrs. Taylor and Mr. Greenspan.

One general comment might be made about the methods which have been followed: techniques such as regression analysis and input-output analysis have been used extensively and are of considerable help; however, the B.L.S. has found that the factors affecting employment are so complex and subtle that not all of them can be dealt with mathematically, and in the last analysis a considerable degree of judgment has entered into the projections. The quantitative techniques have provided first approximations, but not final answers.

The B.L.S. welcomes this conference and looks forward to being able to benefit by ideas suggested by the participants and by the work that they have been doing; and it hopes that through this interchange all economists will be stimulated to develop new and better approaches to some of the exceedingly difficult problems in this area.

## PROJECTIONS OF THE LABOR FORCE

After a brief introduction by Gertrude Bancroft (B.L.S.), Sophia Cooper (B.L.S.) described the methods now being used by the Bureau of Labor Statistics in making labor-force projections. The following is a summary of her comments.

# NOTES ON LABOR FORCE PROJECTIONS

By Sophia Cooper

In the last 5 years, the Bureau of Labor Statistics has issued two publications on labor force projections. The first came out in 1959 (Bureau of Labor Statistics Bulletin No. 1242, "Population and Labor Force Projections for the U.S., 1960 to 1975"); the second in 1962 (Special Labor Force Report No. 24, "Interim Revised Projections of U.S. Labor Force 1965-75"). Another report is underway. It will be based on the Census Bureau's latest population projections and will incorporate more recent information on labor-force participation and trends in factors affecting work activity of various population groups.

The general approach used in preparing the labor-force projections has been to project labor-force participation rates separately for the various age-sex groups and to apply these rates to the future population in each group. The trends in labor-force participation rates for the various age-sex groups can be summarized briefly. (Samples of time-series graphs showing labor-force participation projections for various groups were distributed to conference participants.) The rates for men in the central ages 25 to 59 are high and have shown little variation. For young men of school age, the overall rates have been declining, reflecting primarily greater proportions in school. Rates for older men have been declining, with earlier retirement increasing because of the extension of private pension plans and provisions for earlier retirement at reduced benefits under social security. The most dramatic change has been the rising rates for adult women, particularly among those 35 years and over.

In projecting the labor-force participation rates for the various sectors, a number of specific demographic and social factors which are known to influence the extent of labor-force activity of particular age groups of men and women were taken into account. For example, a continuation of increased school enrollment of young persons was built into the projections since labor force activity of students is much more limited than of young persons no longer in school. In addition, the proportion of women in ages 20 to 44 with children under 5 years old was projected, based on trends in fertility and child spacing, because of the much more restricted work activity of mothers of young children. Similarly future marital status distributions of older adult women were incorporated into the projections because of differential levels and trends in labor-force participation rates by marital status.

For each of these subgroups, trends in labor-force participation rates by age were extrapolated, then weighted by their respective future populations and the resulting labor force summed to provide the total labor force and labor-force participation rate for each age-sex group and for all ages.

The extrapolation of past trends in labor-force participation rates for the various groups has been done by judgmental fitting of trend lines, with allowances made for temporary effects of economic disturbances. The projections have assumed high levels of economic activity and continued expansion without being tied specifically to variations in the performance of the economy.

We have been trying out some alternative approaches to projecting labor-force participation rates, including multiple regression analysis in which the rates are related to various measures of economic activity and social or demographic factors affecting work activity. Up to this point the relationships have not provided reasonable results.

Further work needs to be done on a number of problems. For example, it would be important to study the effect on labor-force participation rates of adult women of the large numbers of young persons entering working age; the factors affecting the withdrawal of older men from the labor force; and the effect of changing economic conditions on labor-force rates of women and other groups.

## DISCUSSION

In the discussion following Miss Cooper's presentation, the following points were made, among others. We need to make short-term projections of the labor force which will take into account expected changes in economic conditions. Also, we need to do more work on the problem of how, and to what extent, we should incorporate recent or current experiences into long-term projections. Reference was made to the recent tendency toward early marriage combined with having children soon after marriage and fairly close together. How will this affect the long-term trend of participation rates for women?

William Bowen (Princeton University) reported briefly on his current research. He has been carrying on a study of labor-force participation rates by metropolitan area. This involves a cross-section study of experience in about 100 cities, which vary as to levels of unemployment, industry and occupational composition of the labor force, etc. The analysis is confined to the census years 1940, 1950, and 1960. Primary reliance is placed on regression techniques. The study is still in progress. The results thus far obtained show an inverse relationship between the rate of unemployment and the participation rate for all of the age-sex groups studied.[1]

James Tobin (Yale University) suggested that a factor which should be taken into account is the trend in part-time participation. Is the rate of part-time participation in the labor force going up, going down, or staying about the same?

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[1] A more detailed progress report on this study has since been published. See W. G. Bowen and T. A. Finegan, "Labor Force Participation and Unemployment," in Arthur M. Ross, ed., Employment Policy and the Labor Market (Berkeley, University of California Press, 1965), pp. 115-161.

R. A. Gordon asked if anyone was conducting studies on trends in part-time participation. None of the participants knew of any under way.

Thomas Dernburg (Oberlin College) reported on research which he had been carrying on with Kenneth Strand, formerly at Oberlin and now with O.E.C.D. They have sought to estimate what labor-force participation would have been (in the 1953-1962 decade) assuming various rates of unemployment. Thus far, they have carried out the analysis for unemployment rates of four percent and three percent. Dernburg expressed the view that this is the way to project labor-force participation, rather than by taking into account anticipated cyclical changes. Using this approach, his figures on labor-force participation projections are much higher than the B.L.S. figures. So far, his projections are global, although he is in the process of breaking them down by age and by sex. His main interest is in short-run projections. In addition to the unemployment rate, other variables being used in his model include unemployment compensation being exhausted and population trends.[1]

R. A. Gordon mentioned the problem of reconciling the period of relatively low unemployment prior to 1957 with the period of relatively high unemployment after 1957. This raises the question of the extent to which B.L.S. has allowed the high unemployment of recent years to influence too greatly their long-term projections.

Dernburg pointed out that changes in labor-force participation due to responses to economic conditions sometimes become permanent, so that projections for the future cannot be made on the expectation of going back to the status quo ante

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In a general discussion on labor-force participation of women, Dernburg indicated that, according to his projections, labor-force participation of women between the ages of 45 and 54 would be around 64 percent by 1966. The B.L.S. representatives felt that this figure was much too high.

Alfred Tella (Board of Governors, Federal Reserve System) reported that he has been studying the sensitivity of labor supply to demand. The technique is correlation analysis -- correlation of labor-force participation rates with employment-population ratios. Cyclical trends are included in the projections, which have been made on the basis of groups (age, sex). One of the questions being asked in the study is what would labor-force participation have been under conditions of full employment? Or under conditions of certain unemployment rates? Also, what employment requirements, in terms of age and sex, would be necessary, for example, to achieve a four percent unemployment rate, with an unemployment distribution pattern such as it was in 1956 (the last year when unemployment rate was at four percent)? Preliminary results of the study show that the average annual employment rise between 1963 and 1966 needed to achieve the four percent rate could be as high as 2.5 to 3 million a year. About one-third of this increase in jobs would have to go to the 14-24 age group (of both sexes). The reason for large employment requirements in this age group is their high labor-force elasticity combined with a rapidly growing population. The significance of the coefficients suggests that the model, with trend adjustments, could be used to make short and long-term projections. The model is also being used to measure disguised unemployment and substitutability among labor-force groups.[1]

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[1] For reports on this research, see Alfred Tella, "The Relation of Labor Force to Employment," Industrial and Labor Relations Review, Vol. 17 (April, 1964), pp. 454-69, and "Labor Force Sensitivity to Employment by Age, Sex," Industrial Relations, Vol. 4 (February, 1965), pp. 69-83.

## INDUSTRY PROJECTIONS OF EMPLOYMENT AND TRENDS IN PRODUCTIVITY AND TECHNOLOGICAL CHANGE

The discussion of industry projections was begun by Sol Swerdloff of the Bureau of Labor Statistics, who reported on the work on industry projections of employment now being carried on in the Bureau. This was followed by a report by Edgar Weinberg on the technological outlook studies conducted by B.L.S.

# INDUSTRY EMPLOYMENT PROJECTIONS

By Sol Swerdloff

In estimating future manpower requirements, three general approaches have been followed. One method has been to direct inquiries to employers, asking how many of each kind of worker they expect to employ at some future date. A second is to make quantitative projections of future employment by simple extrapolation of a trend derived from historical data. A third is to analyze the economic and other factors that affect employment in each occupation or industry, and to estimate the future impact of each factor in arriving at a quantitative estimate of future requirements.

Inquiries directed to employers have certain advantages. They are relatively easy to administer and to use as a method of developing estimates of future requirements in large numbers of occupations quickly and at low cost. They presumably draw upon each employer's concrete and intimate knowledge of the situation. They take into account each company's plans for expansion or changes in activity, introduction of new processes, or abandonment of old methods. Not the least of this method's virtues is that it distributes the burden of responsibility for the estimates of future requirements among the respondents, leaving the agency which publishes them in the position of merely reporting what it has been told.

On the other hand this method has certain drawbacks. Few companies or other employers devote time to making long-term projections of their activity or manpower requirements, and thus most employers tend to make only a hasty

guess when confronted with a request for the number of workers they will need in some future year. Even if all employers guessed correctly, they could not provide the data for firms not now in existence but which will be created in the future. The summation of employers' reports, therefore, has often resulted in projections of manpower requirements which appeared to be unreasonable. Some European countries have advanced this technique in that they have asked employers to supply production or activity projections along with their employment projections. By this means, it is possible to compare an employer's projections of employment and production (or activity) and the composite projections can also be compared with independent analysis of the industry's production trends.

The second method -- the projection of quantitative trend lines into the future -- has the merit of simplicity, but very little else to recommend it. Its theoretical justification, when one is offered, is that implicit in the projection of a past trend into the future is the assumption of continued operation of the same complex of causative factors that has affected employment in the occupation or industry in the past.

Unfortunately, manpower problems arise most acutely in situations which reflect a departure from past patterns. For example, the rapid growth of scientific and technical employment in most countries in recent years, or the explosive increase in research activity, depart from the patterns of long-term growth.

The third method is much more difficult -- the painstaking analysis of factors affecting demand for workers in each occupation, or industry, the assessment of how these factors may operate in the future, and the development

of projections based on judgment as to their combined effect on future requirements. This method requires greater resources, the collection of data, the development and training of experienced analysts, and the devotion of considerable time to study. It does not yield quick results, nor does it promise precisely accurate results, since human judgment is involved.

The complexity of this type of analysis depends, in part, on the purpose for which the manpower projections are being made.

As indicated by Mr. Goldstein, except for the growth studies which Jack Alterman will discuss, the program of manpower projection work in the Bureau of Labor Statistics was undertaken for use in our occupational outlook program. In the vocational guidance of young people in schools, it was felt that information should be made available to them on the long-range future employment trends by occupational fields and by industry so that these individuals could make their career choices on the basis of the best possible information, although in our published reports -- such as in the Occupational Outlook Handbook -- we usually did not quantify our estimates of future employment projections. Behind these are a set of occupational and industry projections. A further impetus in developing our projection of occupational requirements and resources was in connection with testing the feasibility of specific mobilization programs in terms of manpower supply. More recently motivation for making projections has been in connection with the planning of education and training programs, that is, to provide information which will help determine how much the educational facilities and activities and training programs must be expanded to meet the nation's future needs for trained workers.

Underlying the projections of employment, by industry and occupation, is research that has been conducted in the Bureau of Labor Statistics over

the past two decades. It includes the systematic compilation of information on employment trends for all the industries of the economy, for geographical areas, and for the major occupations; analysis of trends in production and in output per worker; examination of technological changes which have occurred in the past and analysis of the possible future effects of automation and other technological changes; inquiry into the possible employment effects of a great many long-term programs of government agencies, including those for defense, highways, scientific research, space technology, medical care, and education; and study of the changing occupational requirements of industries as they have been affected by all of these factors.

Underlying the projection of employment for each occupation has been the analysis of factors affecting the demand for workers in the occupation, the assessment of how these factors may operate in the future, and the development of projections based on judgment as to their combined effect on future requirements. The growth of each occupation is affected by its own complex of factors, as Mrs. Taylor will describe tomorrow. The number of teachers required, for example, is affected by the number of pupils (which in turn may be projected by examining birth rates and trends in the proportion of children at each age who attend school) and by trends in the ratio of teachers to pupils, which depend upon educational practices and financing. Thus, for many occupations intensive study of the factors affecting employment can furnish the basis for direct estimates of future demand in the context of the estimated growth of population.

However, projecting requirements for most occupations, especially those employed in industry, requires analysis of the outlook for production and employment in each of the major industries employing workers in the

occupation, as well as trends in the use of each occupation in the industry.

Over the years we have made projections of employment by industry in varying level of detail. At the present time, in connection with our current revision of the Occupational Outlook Handbook, we are making industry projections to the 3-digit S.I.C. level.

Projections for individual industries are based on such factors as expected changes in the total domestic production of each product or service, competition with other products or services, expected technological changes, changes in hours of work, etc.

In projecting activity levels of individual industries it is necessary first to establish the nature of the demand for the industry's products or services and the relationship of this industry to the growth of the whole economy. Obviously, if an industry is producing products directly for consumers, it will have a different type of demand function than an industry which is making raw materials to be used as a component for further manufacturing.

For example, in projecting production of steel, consideration must be given to the expected increase in population and the trend in per capita steel output. The total requirements for steel depend on the requirements projected for each of the principal steel-using industries, such as the automobile, construction, electrical appliances, machinery containers, etc. In effect, it is necessary to project the output of each of these industries in order to estimate total steel requirements. Consideration must be given to the competition to steel from other materials such as aluminum and plastics. An evaluation of the import-export balance must be made.

In projecting the output of the automobile manufacturing industry, the nature of the market suggests approaching separately an appraisal for the output of passenger cars and for trucks, since it is obvious that the demand for each of these products will have a different causal pattern. In addition, the production of replacement parts and accessories for sale to garages, or directly to automobile and truck owners, must also be considered, since their manufacture requires a significant portion of employment in the industry. So the first step is to make a rough division of the production of the automobile industry among these three major components, each with a different type of market structure, and to make a projection for each.

Demand for passenger cars will be affected by such factors as the level of economic activity, the level of income and distribution among income groups, the growth of population and household formation, the move to the suburbs, and the growth of multiple car ownership. The demand for trucks is dependent on the growth in requirements for hauling by farmers and commercial and industrial users and the competition by other transportation mediums. Another important element in the demand for motor vehicles is the total number of cars, trucks, or buses in use, because a certain percentage of new vehicles are needed each year to replace those being scrapped. In fact, this factor is perhaps the major determinant in total production. The sale of replacement parts and accessories is also influenced by the number and age of the vehicles in operation.

Industry production or activity levels for a future period can then be translated into overall manpower requirements by estimating the change in output per man-hour (i.e., productivity) and by making assumptions as to changes in hours of work.

Because of the amount of resources necessary to make an intensive study of each industry in the economy, a more global type of analysis has been used to fill the gaps.

In this, the usual starting point is the total demand of the economy for goods and services; this can be apportioned among the requirements for each major product or service (classified by industry). The estimates of production can then be translated into requirements for workers -- in total and by occupation.

The general approach is to begin with population and labor force projections and then project the growth of the economy assuming generally full employment, the achievement of which is the primary objective of the government. GNP projections have sometimes been computed utilizing labor-force projections, assumptions as to the size of the armed forces and the level of unemployment, and projections of annual hours of work and output per man hour. Or instead of computing a GNP, we can use some assumption as to the rate of economic growth such as that agreed to by the United States with fellow members of O.E.C.D. -- of an increase of 50 percent in GNP from 1960 to 1970.

Gross national product (GNP) projections are used as one analytical tool in developing industry projections. For some industries, activity levels are estimated by analyzing their relationship to GNP or one of its major components, such as personal consumption expenditures. Another analytical tool is the past relationship between employment in each industry and total employment, analyzed by means of regression techniques. Relationships between employment in each of the broad industry divisions and total nonagricultural

employment were analyzed first. Then, employment in each of the industry groups within the major industry divisions was related to the total in the division. Finally, each detailed industry within each of the industry groups was related to the group total. By this procedure, a consistent set of relationships was obtained. The effect of this method of analyzing the regression of employment in each industry on total employment is to take account implicitly of all the factors affecting this relationship in the period from which the data used in the regression were obtained. A refinement of this analytical technique that we are using now involves the use of multiple correlation, taking into account, in addition to the employment trends, such factors as unemployment, size of the armed forces, GNP, and population. By this technique, for each 3 or 4 digit industry for which data are available, cyclical and other factors were separated from secular trends, thus providing a tool for projecting industry employment at assumed levels of economic activity consistent with different rates of unemployment. This technique, for example, imputes more realistically the direct and indirect effect of various economic influences associated with various levels of unemployment on employment in individual industries.

At times we have experimented with analyzing the past relationship between the production in each industry and total projected production as a means of projecting industry production levels in much the same way as for employment levels just described, and then translating industry projections into employment by consideration of trends in output per man hour and hours of work.

The results of the various types of analyses made as indicated are the basis for judgment decisions as to the level of employment in the projected period. The considerable amount of information on individual industries developed in the course of the occupational outlook program and discussions with representatives of industry and unions provided essential background in making these judgments. Analysis of trends and projections for the economy as a whole, for separate states, or for individual industries made by other groups -- such as N.P.A., Stanford Research, state and local governments, and universities -- also contributes to these judgments.

I cannot emphasize too strongly that in the final analysis, our industry projections are essentially judgments based on whatever kinds of data and assessments that it was possible to find or make.

As you will hear tomorrow from Mrs. Taylor and Mr. Greenspan, manpower requirements in each industry can be distributed by occupation on the basis of information on the changing composition of each industry. For each occupation an estimate of total requirements can be made by summing the requirements for that occupation in all industries. The number of people who have to be trained for each occupation can then be estimated by computing the net growth required in the occupation and the number of workers needed to replace those dying, retiring, or otherwise leaving the occupation.

# B.L.S. TECHNOLOGICAL OUTLOOK STUDIES

By Edgar Weinberg

The B.L.S. program of technological outlook studies is designed to provide information on a number of key topics: the nature of the impending changes in equipment, products, processes, and materials, the current status of these innovations, the economic advantages and disadvantages of the change that will affect its adoption, the possible trend in usage over the next 2, 5, or 10 years, the implications for labor productivity, occupational change, training requirements, and collective bargaining.

These studies are concerned principally with innovations in some stage of commercial use, which experts can readily identify, rather than with the prospects for new inventions or developments that are still under research.

Much of the B.L.S. program on technological outlook is new. Previous studies have been primarily case studies, at the establishment level, of adjustments to technological change[1] and two industry studies.[2] The current program is, therefore, subject to modifications as new study techniques are developed.

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1. Studies of Automatic Technology: "A Case Study of a Company Manufacturing Electronic Equipment" (October 1955), "The Introduction of an Electronic Computer in a Large Insurance Company" (October 1955), "A Case Study of a Large Mechanized Bakery" (September 1956), "A Case Study of a Modernized Petroleum Refinery" (September 1957), and "A Case Study of an Automatic Airline Reservation System" (July 1958); Adjustments to the Introduction of Office Automation (a study of the installation of large computers in 20 companies), B.L.S. Bulletin 1276 (May 1960); and Impact of Office Automation in the Internal Revenue Service (B.L.S. Bulletin 1364, July 1963).

2. Technological Change and Productivity in the Bituminous Coal Industry, 1920-60 (B.L.S. Bulletin 1305, November 1961), and Impact of Technological Change and Automation in the Pulp and Paper Industry, 1947-60 (B.L.S. Bulletin 1347, October 1962).

Two approaches to the study of technological outlook are being followed: (1) A series of studies of key industries analyzing major technological trends and their implications; (2) a series of studies of different types of innovations that have an impact on a large number of industries.

As part of its industry program, the Bureau prepared for the President's Advisory Committee on Labor-Management Policy a report on Technological Trends in 36 Major American Industries, covering the status and outlook of impending developments in each industry.

More detailed industry studies are being undertaken in a number of key industries such as electric power, transportation, textiles, and foundries, with others to follow at a later date. Since the industry as a whole is of concern, these studies also involve analysis of recent trends in output per man-hour, production and employment, and the implications of past rates of growth or decline for future trends.

Some attempt must be made to translate qualitative information about changes in technology into quantitative estimates of changes in the trend in unit labor requirements and other economic variables. Basic data for this purpose are the statistical series of the industry. Some new approaches involving cross-sectional plant data may also be attempted. The possibility of developing information about productivity levels in the best plants of an industry is being explored, utilizing plant reports collected in the Census of Manufactures. Other sources are engineering studies of the best plant practices. Such information would be useful in estimating future productivity trends for the industry.

The second approach to be followed in assessing the manpower implications of technological change involves intensive study of innovations that may affect a large number of industries. Since various operations such as data processing,

machining, communication, and materials handling have more or less similar characteristics in all industries, information about the technological innovations would have wide applicability.

Research is being carried out on the status and impact of such innovations as computers and numerically-controlled machine tools. The Bureau undertook a mail survey of over 400 insurance companies in 1963 to determine the extent of computer use and some of its employment effects. Among the topics covered in this study are the number of computers in use and to be installed and the impact on labor requirements for various occupational groups.

## ESTIMATING MANPOWER REQUIREMENTS IN PROJECTING THE GROWTH OF THE ECONOMY

Both in and out of the federal government, various groups have been seeking to project the growth of the American economy. Manpower projections enter into such growth studies in a variety of ways. On the one hand, expansion of output is limited by the labor supply and changes in productivity. On the other, the expansion in aggregate demand for output, adjusted for changes in labor productivity, determines how fast employment will rise. And when we dig below the simple aggregates, such questions arise as: How will the pattern of demand alter as output expands? What will be the differential changes in the demand for labor, by industry and by occupation? And so on.

This portion of the conference centered around two reports: one by Jack Alterman of the B.L.S. on the Inter-Agency Growth Project, the other by James Tobin of Yale on the cooperative growth study being carried on by teams of economists at Yale and Massachusetts Institute of Technology. Indeed, one of the reasons for calling the conference at this time arose out of the overlapping interests in manpower projections by the Yale-M.I.T. growth project and the Berkeley research program on Unemployment and the American Economy.

# THE INTER-AGENCY GROWTH PROJECT

By Jack Alterman

1. Project objectives: (a) Try to provide a consistent and integrated framework for evaluating long-term manpower problems; and (b) develop means of exploring implications of changes in government policy and changes in final demand - e.g., implications of change in foreign trade, or changes in a government works program.

2. The Inter-Agency Committee consists of representatives from the Labor Department, Commerce Department, Budget Bureau, and Council of Economic Advisers.

3. The approach used by the committee may be considered a conventional input-output approach. It starts with assumptions regarding growth in population, labor force, hours worked, and productivity. It tries to explore the implications of alternative growth rates and of alternative growth patterns. It is hoped to study at least two growth rate alternatives, and also alternatives in product mix.

4. Phases of the Model

   A. Aggregate GNP Projection (first sub-model)

      Projections of population, labor force, hours worked, productivity. High employment assumed.

      Constant dollar GNP derived.

   B. Projection of national income and product accounts (second sub-model)

      Balance - government receipts and expenditures, savings and investment. Here the project is trying to get a "balanced set of national income accounts."

C. Projections of final demand, output, employment in input-output detail (third sub-model).

(1) Detailed distribution of categories of final demand consistent with input-output table (85 - industry table used).

(2) Using input-output table, get total output of each industry required - both intermediate and final. (Final demands are projections; coefficients of table are projections of base year; will take into account anticipated changes in coefficients.) Trying to make projections for 1970.

(3) Projections of industry output translated into manpower requirements.

At this stage, productivity projections are used to go from output levels to labor demands. Also, we must generate capital requirements and compare with original capital demands which went into final phase and derive new set of capital requirements.

N.B. Iterations to adjust:

(a) Capital formation requirements

(b) Import requirements

(c) Productivity and employment figures

5. Contributors to Research on Model

A. Subcommittee of Inter-Agency Planning Committee, involved in making aggregate projections for GNP - income and product projections. Subcommittee Chairman: David Lusher (Council of Economic Advisers).

B. Consumer Expenditures - Houthakker and Taylor (Harvard).

C. State and Local Expenditures - Selma Mushkin, George Washington University

D. Federal Government Expenditures - National Planning Association.

E. Residential Construction - Office of Business Economics, Department of Commerce.

F. Capital-Output Ratios - Office of Business Economics.

G. Capital Formation - Alterman's staff (B.L.S.).

H. Balance of Payments Study - Walter Lederer (Office of Business Economics).

I. 1958 Input-Output Table - Goldman (Office of Business Economics). Department of Agriculture and Bureau of Mines also participating.

J. Input-Output - Ann Carter (Harvard).

K. Productivity - Leon Greenberg (B.L.S.).

L. Labor Force Projections - Sophia Cooper (B.L.S.).

## DISCUSSION

R. A. Gordon raised several questions. He took issue with the rate of growth (3.5 percent) being projected by the Council of Economic Advisers. He thought this figure was too low for the rest of the 1960's. With regard to the product mix, he pointed out the need to take account of the shift away from commodity to the non-commodity sectors, for example, toward the services. And he raised some questions regarding how we move from estimates of output per manhour to the demand for manpower in terms of the volume of employment.

Alterman suggested that two factors would dampen the increase in growth rates: (1) The favorable influence of the shift from farm to non-farm employment will be of diminished importance and (2) the continued rapid increase in government employment, for which we assume no gain in productivity.

Leon Greenberg (B.L.S.) stated that B.L.S. assumes that changes in the next 5 or 6 years will be consistent with changes in the past. B.L.S. plans to modify its projections as may be indicated by its studies of technological developments.

Tobin raised a question as to the extent to which we could assume that output was really an independent variable. It is not clear to him that the causation runs merely from changes in output to changes in productivity. In making projections to 1970, it is not safe merely to rely on past trends. He then went on to make the following report on the Yale-M.I.T. Growth Project.

# PLANS FOR THE YALE-M.I.T. GROWTH PROJECT

By James Tobin

The leaders of this project are Tobin and Robert Solow (M.I.T.). The project is concerned with the long-run growth potential of the U. S. economy. Projections will probably be for 1973. It is similar to the government growth project in that it is not cyclical, but assumes full employment.

The chief differences from the government project are: (1) The Yale-M.I.T. project is interested in policy measures for changing the growth rate by changing shares in total investment - either by changing investment in plant or equipment, or by changing investment in education. (2) This model is not nearly so disaggregative as the government model. It will use a breakdown of 10-12 industrial sectors.

As far as this manpower conference is concerned, the main problems are these: (1) The project needs some production functions which allow for substitutability. (2) The question must be faced as to how to put labor inputs into production functions. Labor is not to be measured only in man-hours - there are also other dimensions. There is the problem of quality of inputs and relation to choices between tangible investment and educational outlays. How do we project these other aspects of the labor force? We are interested in studying the more durable and basic aspects of labor supply - e.g., we are not sure that a person's occupation or skill category (blue collar, white collar, etc.) is basic. Perhaps what is basic or permanent is a man's education.

In short, the project members want to find out about supply and demand of the various industrial sectors of the economy with regard to these more

permanent characteristics. The research team hopes that the study will be able to say some things about how economic growth will be limited or affected by investment made in education between now and 1973.

In the discussion following the report on the Yale-M.I.T. project, the suggestion was made that the project should take into account such "vintage" elements of labor as date of education, on-job training and other non-formal training, work experience, etc. The question was raised (by Gordon) as to how to project input coefficients for production functions when dealing with different qualitative aspects of labor. The past record -- which reflects past shortages of particular types of labor, past wage relationships, past patterns of education and training, etc. -- may be a poor guide to the future.

Participants tended to agree that we do not really know how much education people need for their jobs. Tobin offered the opinion that people are over educated for their jobs today in a period of a loose labor market. The problem of "drop-outs" may not be that these people are insufficiently educated for the jobs available but, rather, employers in a sluggish market prefer to hire the high school graduate.

## OCCUPATIONAL PROJECTIONS AND CLASSIFICATION

Of the various dimensions of manpower projections, it is probably the occupational dimension which arouses the strongest interest. This was true also of this conference. The reasons for this interest are not hard to find. Changes in the occupational pattern of employment have been dramatic in recent decades. Mobility among occupations is a much more serious problem than it is among industries. Accelerated occupational change raises problems of public policy more than do changes in the industrial pattern of employment (except for the shift from farm to non-farm employment).

At the heart of this concern with occupational trends is the fact that changes in the occupational pattern of employment -- particularly in the world of today and tomorrow -- call for heavy investment and careful planning in education, training, retraining, and vocational counseling.

The conference was fortunate in being able to hear two detailed presentations in this area by experts from the Bureau of Labor Statistics. Both Mrs. Cora Taylor and Harry Greenspan have developed their original oral presentations into the highly informative papers which are presented here. In addition, the report on the discussion which followed these papers contains a brief summary of the report given by Leon Lewis on the system of job classification developed in the Bureau of Employment Security.

# EMPLOYMENT PROJECTIONS BY OCCUPATION

By Cora E. Taylor

Given the framework described earlier -- labor force and industry projections and studies of productivity and technological changes -- it should now be a simple matter to project employment by occupation. We have not found it simple and we are working hard to develop a practical technique for making long-range projections by occupation. Most of our work in this area has centered around our occupational outlook program, designed to furnish information for use in counseling young people concerned with making a career choice. Before the groundwork was firmly laid for this program we were called upon to furnish an assessment of the employment outlook in dozens of occupations for use of the V.A. in their counseling and training program for World War II veterans. Our first Occupational Outlook Handbook was less than one inch thick, but the work that went into the projections underlying the analysis of the employment outlook would have made several such volumes. Five Handbooks later we feel that we have made much progress, but we know we have a long way to go.

In general, we have used two approaches to occupational projections. First, we have made special studies of individual occupations -- particularly the independent professions and the large number of occupations that cut across many industries. Secondly, we have developed occupational composition patterns for each industry, and adjusted these patterns as they respond to industry growth and technological or other changes. For controls we have set up a model which, in its simplest form, is a grid with occupations in the vertical stub and industries in the horizontal stub. For use in this system, current totals for industry employment are available from annual averages of B.L.S. monthly surveys

of workers on establishment payrolls, and projections of industry employment have been based on our industry studies (as described by Sol Swerdloff). These projections will be replaced with those provided by the Economic Growth Studies (described by Jack Alterman).

As you know, one of the major problems in projecting occupational employment is related to the lack of current statistics for use as a "take off" point. The decennial census is the only comprehensive source of employment data by detailed occupation. These data are collected from individuals and do not necessarily correspond to the occupational classifications used by employers -- who furnish the regular industry employment data on production and nonproduction workers collected by B.L.S. Furthermore, the latest population census data are now more than four years old, and it will be approximately eight years before new data from this source are available.

However, on a very broad basis we do have current employment data from the M.R.L.F. This source provides data -- collected from households, not employers -- for 11 socio-economic groups, as well as for about 15 very large, more detailed occupational groupings. Our published projections to 1970 and 1975 of employment by major occupation groups are adjusted to show the trend from the M.R.L.F. average annual employment figures.

So far we have limited our publication of quantified projections mainly to these broad occupational groups, and to special manpower studies which include occupational projections. I would like first to say a few words about our studies underlying projections of employment for some specific occupations, and then Mr. Greenspan will describe the way we fit these and other data into a control system (the matrix).

Occupational employment may be affected by a host of factors. Technological change is the most often discussed and is one of the most significant of these, but occupational changes can also be affected by institutional factors -- for example, union-management relationships and practices, as in the case of the railroad industry. They may be affected by the relative supply in the different occupations -- for example, the substitution effect resulting from shortages of one occupation (such as engineers) and their replacement by members of a second occupation (such as technicians). They may be affected by changes in the scale of operations -- the number of overhead personnel, for example, is less flexible than is the number of production or operating workers as the total scale of operations rises or falls. And, changes in total demand for workers in each occupation also reflect shifts in market demand for the products of each industry, as affected by changes in the level and the distribution of income among consumers, industry and government, and changing patterns of consumption. Thus, to analyze the changing occupational requirements of the economy one must study a great many subjects besides technological developments.

It is obvious that no one technique can successfully be used to project employment in all occupations. The growth in each occupation is affected by its own complex of factors. For example, as mentioned by my colleagues, projections of elementary and secondary school <u>teachers</u> are made by developing pupil enrollment estimates from population-by-age projections (available from the Census) and applying ratios of the average number of pupils per teacher at the various educational levels. However, considerable refinement of this broad approach is necessary.

Projecting the number of pupils involves a minimum of uncertainties, since most states require school attendance at least from ages 7 to 16 -- a few from 6 through 18 years -- and most of the children who will be the elementary-secondary school-age group by 1970 or 1975 are already born. Even so, many related factors must be taken into consideration, e.g., a small allowance must be made for uneducable children, the future attendance rate at the secondary school level -- now about 91 percent of all children in the 14-17 year group -- must be evaluated (we project a moderate increase), and various factors affecting pupil-teacher ratios must be considered. Among these are increasing urbanization, which may tend to increase the ratio by eliminating some schools in rural areas where small enrollments make for a lower pupil-teacher ratio than that prevailing in cities. Curriculum developments, on the other hand, may result in new or advanced courses with small classes (such as advanced mathematics, advanced biology, Russian, and so on) that would have the effect of decreasing the pupil-teacher ratio.

Recent experiments with team teaching, the use of television, the addition of teaching assistants to the staff -- all may affect the pupil-teacher ratio in the future. Consideration of these varying and countervailingpressures on the pupil-teacher ratio, as well as the past trends in the public-private school ratios, suggests that no great change is likely to occur in the ratio by 1975. In the past few years, the pupil-teacher ratio has shown no significant change on a year-to-year basis; for example, in the public elementary schools from 1958 to 1962 the ratio declined only from 28.7 to 1 to 28.5 to 1, while the secondary ratio remained the same at 21.7 to 1.

Since our major interest has been in arriving at a total manpower requirement figure for a given period, a great deal of emphasis is placed on

the assessment of replacement needs (this is especially important in an occupation such as teaching where the replacement rate is high). The Office of Education has done some research in this area and we have used their replacement rates for teachers -- separate for elementary and secondary and for men and women at each level. However, for most occupations we use the labor force life tables developed in the Bureau and applied to the Census age distributions for each occupation. Incidentally, our projections of teacher employment to 1975 indicate a net growth of only 408,000 over 1964 (but the total requirement will be for more than 2 million new teachers over the 10-year period). We have also projected supply under stated assumptions. (See article covering methodology in May, 1964, Occupational Outlook Quarterly.)

Employment projections for engineers, scientists, and technicians require a very different approach. Here the methodology used is based on the trends in the use of S&E in each sector, including private industry, government, and colleges and universities. We are fortunate in having a series of employment statistics by industry from our S.T.P. surveys sponsored by N.S.F., and data are also available for employment in government and education. In projecting, many factors were considered after getting first approximations by projecting trends in the ratios for each industry and applying them to independent industry projections (to 1970). For example, in the aircraft, missiles, spacecraft and related industries, assumptions of future government expenditures had to be made and the impact of these expenditures on technical manpower requirements assessed; e.g., it was assumed that D.O.D. expenditures will increase from $41.2 billion in 1960 to $53 billion in 1970 and in N.A.S.A. from $401 million to $6 billion. Any major change in this factor will, of course, necessitate a reappraisal of

S&E in each of 30 major industry groups and the relationship of R&D expenditures, production, sales, profits, capital expenditures, product mix, technology, and other factors. The depth and method of analysis varied according to the amount and reliability of the data available, but we were able to estimate 1970 employment of engineers, scientists and technicians for each industry. Again we considered replacement needs in order to come up with a total demand estimate and then related projected supply to this to assess future employment opportunities.

Among other occupations for which employment has been independently projected are the medical professions. We have worked with the P.H.S. in projecting physicians, dentists, and nurses. The methodology used is basically that of applying existing ratios of workers to population, taking a variety of factors into consideration -- e.g., changing age composition of population, increasing health plans, use of aides, etc. In medicine, one cannot realistically forecast employment without assessing the supply of personnel -- this can be predicted with near-precision for many years because of the length of time required to establish medical schools and turn out graduating classes. Here, the allowance for replacements is also of major significance.

And so each occupation is considered separately insofar as possible, and related to those factors which significantly affect its growth -- e.g., automobile mechanics are related to number of new autos and gadgets (air conditioning, etc.), and age of used autos, and radio and TV repairmen to number of radios and TV's sold, beauty operators to urbanization, number of working women, and changes in hair styles; policemen to population and urbanization; truck drivers to improved equipment, better highways, and to the competition

from piggyback, fishyback and birdyback transportation methods. But many occupations can best be projected through industry studies.

Some occupations are so concentrated in one industry that a study of the changes taking place in that industry -- its processes, products, technology, etc. -- reveals the trends in occupational employment. For example, the printing trades in the printing and publishing industry; building craftsmen in construction; conductors, locomotive engineers, firemen, brakemen and switchmen, and repairmen in railroads; airplane pilots, navigators, and mechanics in air transportation; tellers in banks; spinners, weavers, knitters, loopers, and toppers, and loom fixers in textile mills; and rollers and roll hands (metal), molders, furnacemen, smeltermen, and pourers, and heat treaters in the metal working industries. One advantage in the industry approach is that employment in all the occupations found in the industry can be evaluated within the framework, and a composition pattern emerges.

This is not to imply that all occupations are similarly affected by the changes taking place in an industry. The railroad industry is a case in point. Statistics on employment by occupation are collected regularly by the Interstate Commerce Commission. The analysis of these changes over a recent 10-year period shows very substantial alterations of the occupational composition of the industry under the impact of changes in technology, in the scale of operations, and in product mix. In the 10 years from 1950 to 1960, the diesel engine completely supplanted the steam locomotive. There were also substantial technical improvements in maintenance of track and roadbed, as section hands who did common labor on the tracks were replaced by mobile units that made repairs as they moved slowly over the track. At the same time passenger traffic declined substantially while freight traffic remained reasonably stable.

The effect of all these changes may be seen in the occupational composition of the industry. Employment dropped by one-third in the decade for a net loss of 440,000 jobs. However, maintenance-of-way employment dropped by 50 percent, a 70 percent decline in section hands being partly offset by a 47 percent increase in the number of portable equipment operators. With the diesel-electric locomotive requiring much less repair work than the steam locomotive, repair shop employment dropped by 47 percent. The boilermakers were the hardest-hit craft; their number declined by 83 percent. On the other hand, employment of electrical workers increasec by 15 percent. Other occupational groups on the railways had smaller declines than the average for the industry. The professional, clerical and general office employees declined by only 21 percent (affected to some extent by the introduction of electronic data processing), and the executives declined by only 1 percent. In projecting employment by occupation we have considered these past changes, made an evaluation of more recent data, talked with knowledgeable personnel in companies, and established a revised occupational pattern for 1970.

Regardless of our approach to occupational projections -- whether occupation-oriented or industry-oriented -- our aim is ultimately to arrive at a projected occupational pattern for each industry. A useful check on projected patterns is to examine the occupational composition of new plants utilizing up-to-date methods and equipment and compare this with the occupational patterns of less modern establishments. However, it is difficult to find establishments with identical products, job classification systems, etc. Furthermore, technological innovations usually are not adopted extensively in an industry or an individual plant at a single time. Rather, they are adopted, piece-meal, in

the form of a great many minor changes introduced first in one plant and then in another and often in a gradual way even within a single plant. Nevertheless, this approach helps us form a judgment as to the direction of change -- and much of our work must be based on judgment. We also try to get retroactive employment data by occupation in the same plant whenever possible, but this is difficult to come by and, if available, may disguise occupational composition changes since job titles may not change to reflect new duties or skills. We found this to be true in the printing industry in some plants.

But I will refrain from introducing a discussion of our many problems at this point. We feel that we are making some progress, even with our limited resources. We hope that we will find a growing number of research projects from universities and other agencies that will contribute to occupational employment statistics -- current and projected. At this point we do not have the resources to do extensive research, and our coverage of the detailed occupations and the structure of industries is very uneven.

If we had a good current occupational pattern for each industry and a thorough and continuous assessment of technological change and its effect on the occupational structure, we would be in business. Unfortunately, until there is a regular collection program of occupational employment statistics we will have to "make do" with fragmentary data. In accordance with the Gordon Committee's recommendations, this Bureau has begun exploratory work on an employer-oriented collection program. We hope we will begin collection of data in the fiscal year 1966. To handle whatever occupational statistics are available and to keep our projections within reasonable bounds, we have developed a tool -- a model sometimes referred to as a matrix.

(Mr. Greenspan will discuss this and its use.)

# ESTIMATES OF EMPLOYMENT REQUIREMENTS BY OCCUPATION FOR FUTURE PERIODS -- DATA SOURCES AND MODEL DEVELOPMENT

By Harry Greenspan

I would like to shift our attention from projections of employment in selected occupations and industries to procedures for estimating employment in future periods for a set of occupations which is complete for all employment in the economy and consistent with the employment projections presented here yesterday.

In short outline the work requires:

a. That estimates be prepared of the occupational composition of individual industries for future periods. The occupational composition of each industry would be in the form of the percent of total industry employment found in each occupation.

b. That the future occupational ratios be applied to projections of employment in each industry and the products summed across all industries to arrive at total employment by occupation for the entire economy.

The projections of industry employment will come from the Economic Growth Project, which was discussed here yesterday, or from other projections of employment by industry. The part we are struggling with that I want to discuss with you is the preparation of the future occupational patterns for specific industries. The model we are working with will be somewhat more disaggregated than the one Professor Tobin described a short while ago. In our model the economy is divided into about 125 industry sectors, and employment is to be developed for about 150 occupations or occupational groups, which will also be exhaustive.

The reasons for working with the occupational patterns of individual industries should be clear. Occupations which are important in one industry may be unimportant or non-existent in other industries. An uneven growth of industry sectors caused by shifts in the demand for goods and services will influence national occupational patterns.

For example, truck drivers made up about 60 percent of total employment in the trucking industry in both 1950 and 1960. During the 10-year period, output in the trucking industry, as indicated by total employment, increased by about one-third, and employment of truck drivers in the industry increased almost in proportion. The employment increase for drivers in the trucking industry, which amounted to more than 100,000 workers, accounted for about half the increase in truck and tractor drivers for the nation, as estimated by the Census.

On the other hand, employment in railroads dropped by one-third. Truck drivers make up only 1½ percent of employment in that industry, and the small absolute decline in their employment had little effect on the national employment total for truck drivers. But employment in occupations which are highly concentrated in the railroad industry, such as locomotive engineers, locomotive firemen, brakemen and switchmen, suffered a substantial decline. The entire drop in employment of locomotive engineers between 1950 and 1960 -- a reduction of about 14,000 --- was found in the railroad industry.

Or if we compare larger industry groups, it should be obvious that a more rapid growth for banking and insurance than for the construction industry will significantly determine the relative employment growth in the construction crafts and office clerical employees. The long-term shift of employment from the goods-producing to the service sectors of the economy has had a significant effect on the occupational structure of employment.

Employment of Locomotive Engineers and Truck and Tractor Drivers in the Railroad and Trucking Industries, 1950 and 1960

| | Railroads and railway express service | | | Trucking | | |
|---|---|---|---|---|---|---|
| | 1950 (in thousands) | 1960 | Percent change | 1950 (in thousands) | 1960 | Percent change |
| Total employment | 1383 | 944 | -32 | 598 | 793 | +33 |
| Locomotive engineers | 66 | 52 | -21 | 0 | 0 | -- |
| Truck and tractor drivers | 16 | 14 | -12 | 368 | 481 | +31 |

Source: Census Occupation by Industry Tables for 1950 and 1960.

Over a period as short as 6 to 10 years, there is probably a relatively stable occupational structure within many industries. If this is so, a set of good occupational patterns for a base period and good projections of employment for each industry comprise a major step toward projections of employment by occupation.

In a very rough way we have tested the importance of relatively stable occupational patterns within industries, and greater employment growth for some industries than for others, on the changing occupational structure of total employment. Using data from the 1950 and 1960 Censuses, the actual change in employment for the 11 broad occupational groups was compared with the change that would have occurred if the industry employment had changed as reported but the occupational patterns for detailed industries had remained as they were in 1950.

For one group - non-farm laborers -- the actual change and the change implied by constant occupational patterns were in opposite directions. In a second case -- managers, officials and proprietors -- the industry employment

Change in Employment by Broad Occupational Groups, as Reported in the Population Census and as Indicated by Industry Employment Changes, 1950 to 1960

| | Employment reported by the Census | | 1960 employment if total in each industry changed as reported in the Census but the occupational patterns within the industries remained as in the 1950 Census | Change in employment | | Percent of reported change picked up by industry growth factor |
|---|---|---|---|---|---|---|
| | 1950 | 1960 | | Reported by Census | Resulting from industry growth factor alone | |
| | (000) | (000) | (000) | (000) | (000) | |
| Total employment[1] | 55,507[2] | 61,465[2] | 61,465[2] | 5,958 | 5,958 | 100 |
| White collar workers | | | | | | |
| Professional workers | 4,910 | 7,223 | 7,140 | 2,313 | 2,230 | 96 |
| Managers, officials, etc. | 5,018 | 5,408 | 5,699 | 390 | 681 | 175 |
| Clerical workers | 6,895 | 9,303 | 8,622 | 2,408 | 1,727 | 72 |
| Sales workers | 3,927 | 4,644 | 4,636 | 717 | 709 | 99 |
| Blue collar workers | | | | | | |
| Craftsmen | 7,783 | 8,753 | 8,763 | 970 | 980 | 101 |
| Operatives | 11,140 | 11,920 | 11,971 | 780 | 831 | 107 |
| Laborers | 3,431 | 3,093 | 3,572 | - 338 | + 141 | --- |
| Service workers | | | | | | |
| Private household workers | 1,408 | 1,716 | 1,643 | 308 | 235 | 76 |
| Other service workers | 4,287 | 5,456 | 5,286 | 1,169 | 999 | 86 |
| Farm workers | | | | | | |
| Farmers and farm managers | 4,309 | 2,508 | 2,643 | -1,801 | -1,666 | 93 |
| Farm laborers and foremen | 2,400 | 1,440 | 1,491 | - 960 | - 909 | 95 |

1. Excludes persons who did not report their occupation.
2. Parts may not add to totals due to rounding.

Source: Department of Commerce, Bureau of the Census; "1950 Census of Population," Volume II, Part 1, Table 53, pp. 101.
Department of Commerce, Bureau of the Census; "1960 Census of Population," Series PC(2), 7C, Table 2, pp. 7-146.
Department of Commerce, Bureau of the Census, Special tabulation of 1950 occupational employment by industry prepared for Department of Labor.

changes implied a growth 75 percent larger than occurred. In both these cases, incidentally, the base was relatively small -- a change of 400,000 workers or less. In the remaining 9 occupational groups, the industry growth factor picked up between 72 percent and 107 percent of the reported change in employment. We have not had time to test this factor for the detailed occupations although the results would be of great interest.

As we all know, however, the occupational composition of industries changes over time, and evaluation of the changes that are likely to come by 1970 or 1975 is the second major step, which, when carried out as well as we are able, will complete the basic work and provide the future industry-occupational patterns we seek. A single example will illustrate that this factor can be important for specific occupations. The telephone industry grew by one-sixth in the decade of the 1950's. Nevertheless, employment of telephone operators was reduced because of the expanded installation of automatic dialing. Telephone operators were about 45 percent of total employment in the industry in 1950 but only 30 percent in 1960. Their share of the telephone industry's employment dropped by almost one-third in the decade. Incidentally, it is probably wrong to project the decline of the past decade through the 1960's. Almost 100 percent of local calls are now placed through automatic dial systems and, although the extension of automatic dialing to long distance calls is continuing, many of the operators now employed handle information requests and other special calls which are not as susceptible to technological displacement.

Employment in the Telephone Industry, 1950 and 1960
(in thousands)

| | 1950 | | 1960 | | Percent change |
|---|---|---|---|---|---|
| | Number | Percent | Number | Percent | |
| Total employment | 595 | 100 | 692 | 100 | +16 |
| Telephone operators | 262 | 44 | 218 | 31 | -17 |

Source: Census Occupation by Industry tables for 1950 and 1960.

If historical data on the occupational composition of industries are available, studies can be made to understand factors underlying past changes in occupational patterns to determine whether they are likely to continue into the future, or must be modified in some manner.

Statistics on Employment by Occupation

What data are available for preparing current and projected industry-occupational patterns? Some sources are well known; others may be new to you. Let me review them quickly.

The major source of information on employment by detailed occupation has been data gathered during the decennial population censuses. In 1960 employment estimates were developed for 297 occupations or occupational groups. These were cross-tabulated into 149 industry sectors, which were complete for the entire economy. Approximately the same occupation by industry detail was prepared as a result of the 1950 Census.

Between Census years the only complete estimate of employment comes from the Monthly Report on the Labor Force (M.R.L.F.) based on a sample survey of 35,000 households. Total employment distributed to about 25 occupational groups is available from the M.R.L.F. since 1957, and in more condensed fashion -- i.e., 11 occupational groups -- since the 1940's.

The projections of total employment with which our occupational projections should agree are based on data from the M.R.L.F. In concept, the M.R.L.F. and the Census are alike. The same occupational classification system is used. The forms used in the Decennial Census and the M.R.L.F. for collecting occupational data are comparable. The Census has been the only source of information on employment for a relatively detailed list of occupations which is complete for all types of work. The cross classification of employment by occupation and

Employment by Occupational Group, Census and M.R.L.F., April, 1960, and Relation of Census to M.R.L.F., 1950 and 1960

| Occupational group | Employment, April, 1960 | | Census as a percent of M.R.L.F. | |
|---|---|---|---|---|
| | Census | M.R.L.F. | April, 1960 | April, 1950 |
| Total employment | 64,639 | 66,159 | 98 | 96 |
| Occupation not reported | 3,184 | 0 | -- | -- |
| Total, occupation reported | 61,455 | 66,159 | 93 | 95 |
| White-collar | 26,587 | 28,583 | 93 | 93 |
| Professional, technical and kindred | 7,232 | 7,550 | 96 | 110 |
| Medical and other health workers | 1,306 | 1,294 | 101 | |
| Teachers, except college | 1,672 | 1,737 | 96 | |
| Other professional, tech. and kindred | 4,254 | 4,519 | 94 | |
| Managers, officials and proprietors | 5,410 | 6,960 | 78 | 79 |
| Salaried workers | 3,388 | 3,445 | 98 | |
| Self-employed, retail trade | 1,019 | 1,809 | 56 | |
| Self-employed except retail trade | 1,003 | 1,706 | 59 | |
| Clerical and kindred workers | 9,306 | 9,651 | 96 | 91 |
| Stenos, typists and secretaries | 2,256 | 2,414 | 94 | |
| Other clerical and kindred | 7,050 | 7,237 | 97 | |
| Sales workers | 4,639 | 4,422 | 105 | 101 |
| Retail trade | 2,695 | 2,698 | 100 | |
| Other sales workers | 1,944 | 1,724 | 113 | |
| Blue-collar | | | | |
| Craftsmen, foremen and kindred workers | 8,742 | 8,592 | 102 | 104 |
| Carpenters | 819 | 832 | 98 | |
| Construction craftsmen except carpenters | 1,600 | 1,670 | 96 | |
| Mechanics and repairmen | 2,223 | 2,038 | 109 | |
| Metal craftsmen except mechanics (includes machinist and job setter) | 1,113 | 1,104 | 101 | |
| Other craftsmen and kindred workers | 1,811 | 1,818 | 100 | |
| Foremen, not elsewhere classified | 1,175 | 1,130 | 104 | |
| Operatives and kindred workers | 11,898 | 11,996 | 99 | 94 |
| Drivers and deliverymen | 2,321 | 2,305 | 101 | |
| Other operatives and kindred workers | 9,577 | 9,691 | 99 | |
| Durable goods manufacturing | 3,801 | 3,480 | 109 | |
| Nondurable goods manufacturing | 3,686 | 3,364 | 110 | |
| Other industries | 2,090 | 2,847 | 73 | |

(Table continued on next page)

| Occupational group | Employment, April, 1960 | | Census as a percent of M.R.L.F. | |
|---|---|---|---|---|
| | Census | M.R L.F. | April, 1960 | April, 1950 |
| Laborers, except farm and mine | 3,108 | 3,569 | 87 | 109 |
| Construction (male only) | 645 | 724 | 89 | |
| Manufacturing | 984 | 1,144 | 86 | |
| Other industries | 1,479 | 1,701 | 87 | |
| Service workers | 7,171 | 8,328 | 86 | 85 |
| Private household workers | 1,726 | 2,182 | 79 | 73 |
| Service workers except private household | 5,445 | 6,146 | 89 | 90 |
| Protective service workers | 690 | 788 | 88 | |
| Waiters, cooks and bartenders | 1,560 | 1,727 | 90 | |
| Other service workers | 3,195 | 3,631 | 88 | |
| Farmers and farm workers | 3,951 | 5,089 | 78 | 96 |
| Farmers and farm managers | 2,506 | 2,869 | 87 | 94 |
| Farm laborers and foremen | 1,445 | 2,220 | 65 | 100 |
| Paid | 1,166 | 1,301 | 90 | |
| Unpaid | 279 | 919 | 30 | |

Source: U. S. Census of Population, 1960. United States Summary, Detailed Characteristics, table 202, Current Population Reports, Labor Force, March 1951 both issued by the U. S. Department of Commerce, Bureau of the Census, and Employment and Earnings, February 1964, Table A-19, p. 82, U. S. Department of Labor, Bureau of Labor Statistics.

industry for both 1950 and 1960 provides a highly useful framework for carrying out studies of current and projected occupational composition patterns for individual industries.

However, life is not that easy. Because of the use of highly trained and closely supervised interviewers, the data published in the M.R.L.F. are considered more reliable than Census data for estimates large enough to have a relatively small sampling error. For April 1960, the Census estimate of total employment was 1½ million below that of the M.R.L.F. Of those reported as employed, the Census had insufficient information to identify the occupations of 3.2 million. Consequently, in the Census, occupations are identified for about 61½ million workers, compared to the more than 66 million reported as employed by the M.R.L.F. Nor was the Census undercount evenly distributed among occupational groups. For some occupational groups the Census estimate was about the same as, or somewhat larger than, the M.R.L.F. estimate; for others it was substantially lower. As a further complication, the differences between the Census and the M.R.L.F. for 1950 and 1960 were not particularly consistent.

Our interest extends beyond the broad occupational groups to specific occupations. Doubts about broad group estimates in the Census are likely to be sharpened when we consider detailed occupations. Any errors in the broad group estimates in the Census are averages of errors for the detailed occupations in the group, and a broad group estimate in the Census which appears reasonable in total may result from offsetting errors for individual occupations. In addition to the Decennial Censuses and the M.R.L.F., which provide estimates of total employment, there are a number of sources of good information on one or a few occupations, or on the occupational composition of particular industries. These may be grouped into four categories.

1. Estimates which can be developed from licensure statistics or membership records of professional societies. Employment data are available from these sources for about 1,200,000 workers in 10 occupations. All but two of the occupations in this group are in the medical and health fields.

2. Surveys of employers by Federal agencies to obtain estimates of employment of scientists, engineers, and related technicians; college teachers, librarians, and policemen. Data are collected on about 2 million workers in 10 occupations. Also collected are data on teaching positions in elementary and secondary schools, which numbered about 1,750,000 in the 1962-63 school year. The Civil Service Commission collects data on employment in the federal government by occupation or occupational group. Usable data from this source cover about 800,000 workers, about half of whom are in occupations found only in the Post Office.

3. Occupational structure information is filed with federal agencies by regulated industries (railroads, telecommunications, airlines, pipelines, and interstate motor carriers). Employment data on 600,000 workers in 8 occupations which are heavily concentrated or entirely in these industries can be obtained from the regulatory agencies. Additional information on employment in broad occupational groups is also available for each industry.

4. Occupational estimates may be developed as a by-product of the Bureau's wage-rate studies for about 30 occupations found in many industries plus others which are concentrated in specific industries.

Not counting the data that may be developed incidental to wage studies, estimates are available from non-Census and non-M.R.L.F. sources for about 6.4 million workers. Preliminary investigations indicate that wage study data can provide information on another 3 to 4 million workers identified by detailed occupation and industry. Though not distributed by industry, estimates are also available from the M.R.L.F. since 1957 for carpenters (800,000 employed); secretaries, stenographers, and typists (2,400,000); and drivers and deliverymen (2,400,000).

Comparing the Census estimates for detailed occupations with some of the other sources considered to be reliable, we again find a mixture of good and bad matching.

Employment Estimates for Selected Occupations, Census and Other Sources, 1960

| Occupation | Employment (in thousands) | | | Description of other source |
|---|---|---|---|---|
| | 1960 Census | Other source | Census as a % of other source | |
| Engineers[1] | 681 | 649 | 105 | B.L.S. Survey of Employment of Scientific and Technical Personnel in Industry |
| Chemists[1] | 67 | 77 | 87 | |
| Draftsmen[1] | 186 | 210 | 89 | |
| Dentists | 83 | 87 | 95 | Licensure statistics |
| Professional nurse | 582 | 504 | 115 | Joint estimate of the Interagency Conference on Nursing, and Statistics based on a variety of data |
| Student nurse | 57 | 115 | 50 | Enrollment statistics |
| Pharmacist | 92 | 117 | 79 | Census of N.A.B.P. members and licensure data |
| Physician | 229 | 225 | 102 | Membership records of A.M.A. adjusted |
| Veterinarian | 15 | 20 | 75 | Membership of A.V.M.A. plus known nonmembers, less retired |
| Telephone operators[2] | 220 | 218 | 101 | Data submitted to the Federal Communications Commission |
| Postmaster | 36 | 35 | 103 | Post Office payroll records |
| Postal clerk and supervisor | 212 | 258 | 82 | |
| Mail carrier | 196 | 204 | 96 | |

1. Includes private wage and salary workers outside of colleges and universities and non-profit organizations.
2. Telephone industry only.

Excluding Census statistics, we have or hope to be able to develop time series data for detailed occupations distributed by industry for 9 or 10 million workers. Although national estimates not distributed by industry will be available for a number of other occupations from the M.R.L.F., we will still fall far short of our requirements for current and historical occupational employment information.

Preparation of the Industry-Occupational Patterns for 1960

As stated earlier, the first step toward projections has been to prepare the best estimates possible of the occupational composition of about 125 industries for 1960. Much of the basic data come from the Census Occupation by Industry tables. Yet few of the final figures are the same as those in the Census.

First, all estimates of occupational employment considered reliable and preferable to Census data have been introduced as constants. These include data from various sources mentioned above. Most of the sources used in place of the Census also provide us with a series of annual estimates which will prove useful in analyzing future occupational patterns. Second, Census data for the remaining cells in the occupation-by-industry table were forced alternately to horizontal and vertical marginal controls which consisted of M.R.L.F. occupational group totals in one direction, and total employment in each industry in the other direction. The table thus has been made consistent with data which are the basis for the projections of total employment in the economy to 1970 and a set of employment projections for individual industries which will be prepared as part of the Economic Growth Project.

Projections

The procedure presently being considered for projecting employment by detailed occupation has certain similarities to the preparation of the base-period occupation-by-industry table. Estimates from special studies for individual occupations such as those for teachers, doctors, scientists and engineers, or studies of the occupational patterns for specific industries such as those for railroads and airlines, will be entered into our table for 1970 as constants. These will include estimates from the studies which have been described earlier in these meetings and any others which we find to be useful.

Many of the occupational estimates, however, will be developed by examining trend data on the occupational patterns for each industry and making additional analysis of the effects of technological change based on studies of the Office of Productivity or on library research. The effects of changing product mix and of institutional and other factors on the occupational patterns of the recent past, and how these factors are likely to affect the projection of past trends to the future, will also be examined. Finally, the information for each industry, whether in the form of numbers or patterns, must be adjusted to 100 percent of the projected industry employment.

Let me quickly review the trend data that are available.

The Population Census provides detailed occupation-by-industry patterns for both 1950 and 1960. We have modified data in the 1950 Census to make the industry divisions as comparable as possible to the 1960 Census. Percentage distributions of the occupational composition of each industry have been prepared. They show the changing share of an industry's total employment represented by each occupation as reported by the Census. The change in pattern from 1950 to 1960 shown in Census data is one of the things we will look at in estimating the occupational pattern for 1970.

A second source of trend data is the estimates of employment of production workers and nonproduction workers in detailed manufacturing and mining industries. These data are gathered for the B.L.S. payroll employment series. In the payroll series, workers are classified into the production worker group by their employers, who provide these data month by month. The resulting estimates of production workers are considered to be highly reliable. For most mining and manufacturing industries the production worker definition can be matched approximately, but not completely, to detailed occupations reported in the Census, or to other sets of occupation-by-industry data which are in about the same occupational detail as the Census.

For those industries for which Census data can be grouped to approximate closely the production worker definition of the payroll series, advantage will be taken of the greater frequency, currency, and reliability of the production worker estimates to provide a control for estimates of employment in detailed occupations. The individual occupations may be estimated to change at varying rates providing that the group as a whole conforms to the change indicated by the production worker statistics through the latest date for which information is available -- 1963 or 1964.

It is expected that the wage-studies data will provide additional indications of the trend for specific occupations in a number of industries through 1963 or 1964. However, it will be necessary to obtain programming and computer time to tabulate much of the data in a form which will be useful for trend analysis.

Trend data from the other sources mentioned earlier, such as licensure statistics, government surveys, and civil service records will also be examined.

Finally, the estimates of trend, since 1960, for detailed occupations and industries developed from various sources will be combined into trends for broad occupational groups in major industries and for the economy. The results at the broad occupational group level will be compared with the actual data for the broad groups reported by the M.R.L.F. through 1963 or 1964, and with projections of the M.R.L.F. broad group data to 1970. Differences with the reported data for 1963 or 1964 must be reconciled; differences with projections of the M.R.L.F. broad groups must be understood and accepted as reasonable, or projections for detailed occupations must be modified.

Obviously, the future effect on occupational patterns of new technology now penetrating economic activity can be foreseen only imperfectly. Also, innovations of which we are at present entirely unaware will occur in some sectors and cause alterations in the skills required. Other uncertainties inherent in projections of industry-occupational patterns need not be detailed here.

The procedure proposed for projecting employment by occupation relies on the belief that the occupational patterns for many industries are relatively stable over periods as short as 10 years, and that the improved industry-occupational patterns prepared for 1960, combined with a systematic effort to evaluate changes in patterns likely to occur in the near future, will provide occupational ratios for each industry which, when combined with good projections of employment by industry, will yield useful information on employment by occupation for future periods.

## DISCUSSION

R. A. Gordon noted that two sets of occupational projections are published in Part 5 of Hearings on the Nation's Manpower Revolution before Senator Clark's Subcommittee on Employment and Manpower. One is by the National Planning Association (for 1972) and the other by B.L.S. (for 1975).

At this point he called on Leon Lewis of the Bureau of Employment Security to report on the Bureau's system of job classification.

Mr. Lewis said that the Bureau's present system of job classification for purposes of statistical reporting relates to the Census Bureau classification system.

The Bureau has developed a new system of job classification for placement and counseling purposes. Every job is classified by a 6-digit number. The first three digits indicate work group identification. The fourth digit indicates the relation of the job to data (0 = synthesizing, 1 = coordinating, 2 = analyzing, ---5 = copying); the fifth digit, the relation to people (0 = "mentoring," 1 = negotiating, 2 = instructing, --- 7 = serving); the sixth digit, the relation to things (0 = setting up, 1 = precision work, --- 7 = handling).

Barbara Berman (Brookings) suggested a research use for the kind of information which could be found in data organized within the framework of the new job classification system: it might provide information about the substitutability of various jobs.

Gordon asked whether any government work was being done on examining information as given in the second set of three digits to establish how much and what kind of education is needed for the particular jobs as identified in the first three digits. (No one knew of any work under way in this area.)

Gordon asked why the National Planning Association projections (see Hearings on the Nation's Manpower Revolution referred to above) on the shift from blue- to white-collar workers is so much greater than the B.L.S. figures. (N.P.A. also predicts a more rapid increase in productivity.)

Mrs. Taylor pointed to two factors making it especially difficult to project growth of white-collar workers: (a) the many white-collar jobs held on a part-time basis by women (this trend is growing); (b) some industries, such as banking, where many white-collar jobs are being replaced by automation, are at the same time expanding services so fast that more white-collar jobs are becoming available in connection with automation.

Myron Joseph (Council of Economic Advisers) raised a question as to whether, in the expanding sectors of the economy, the jobs which are becoming available require a higher level of education.

Greenberg pointed out that the question is not only that of what skills have to be acquired, but also adjustment to a completely different atmosphere surrounding white-collar work vis-a-vis blue-collar work. Also, some people don't want to change because some blue-collar jobs pay more.

Gordon indicated the need for a new approach to thinking about the issue of changing from blue- to white-collar work. In terms of worker attitudes, this may not involve a step "up." He also suggested that there should be non-government research on the whole problem of wage structure and its relationship to job mobility.

Tobin offered the following suggestion regarding occupational mobility with respect to various studies showing that, say, 20 percent or even 10 percent of the labor force has a history of change of occupation. He feels that this should be interpreted as representing a significant amount of occupational

change -- we're interested in this on the margin. It seems that a figure of, say, 10 percent would be high enough to suggest that the research emphasis should perhaps be put on the supply side, rather than on occupational requirements.

Herbert Parnes (Ohio State) inquired whether any study had been made on the relation between productivity level and occupational structure within an industry - for example, comparison of a modern plant with a not-so-modern plant with regard to occupational mixes.

## SUGGESTIONS FOR FURTHER RESEARCH

Sidney Sonenblum (University of California at Los Angeles) made two suggestions for research: (a) greater emphasis should be given to non-manufacturing occupations, with regard to productivity and other things; (b) need for work on sub-national (i.e., geographic) projections. Richard Eckaus (M.I.T.) emphasized the need for research on educational policy. The B.E.S. publications are the only ones in existence which deal with skills required for various occupations.

Goldstein (B.L.S.) suggested the need for research on (a) skills required for each occupation, (b) information on numbers of people who need to be trained in each occupation.

Alterman suggested the following: (a) policy models, such as the one being done at Yale-M.I.T.; (b) in the area of technology.

Gordon pointed out that both A.R.A. and O.M.A.T. have money for research contracts with university groups and, on the basis of the questions raised at this conference, urged those interested and qualified to plan research programs on one or another aspect of the general problem of making manpower projections.

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